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Studies on effect of organic manures and bio inputs on growth, yield and quality of Palak (*Beta vulgaris* var. *bengalensis*)

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Abstract
A field experiment was carried out during *Rabi* season, 2021-2022, at College of Horticulture, Venkataramannagudem, West Godavari district, Andhra Pradesh. The experiment was laid in Factorial Randomized Block Design with single control in three replications. The treatments comprise organic manures *viz*. FYM, Vermicompost, Neem cake and Poultry manure along with Panchagavya and Jeevamrutha as nitrogen sources and bio fertilizers, *Azospirillum* and *Azotobacter* for seed treatment. Among the treatments application of 50% of N Poultry manure + 50% of N panchagavya (V_5) recorded maximum values for growth, yield and quality parameters of Palak. *Azospirillium* @ 20g/kg seed was found superior to *Azotobacter* in biofertilizer treatments. Among the treatment combinations, V_5B_2 - (50% of N Poultry manure + 50% of N panchagavya + *Azospirillium* @ 20g/kg) found to be superior over all other treatments.

Keywords: Palak, organic manures, biofertilizers, poultry manure, panchagavya, *Azospirillium*

Introduction
Palak (*Beta vulgaris* var. *bengalensis*; 2n=2x=18) originated from Indo-Chinese region. It belongs to family Chenopodiaceae. Palak is one of the most popular leafy vegetables with good nutritive value. It is a commonly grown leafy vegetable throughout the tropical and subtropical regions in all types of soils. (Veeraragavathatham, 1998) [12]. It is also known as Indian spinach, beet leaf in English and Palak in Hindi. It is rich source of vitamin A (9770 I.U.), vitamin C (70 mg $100g^{-1}$) and other mineral elements like iron, calcium and phosphorus. It contains 268.60 mg nitrogen, 49.68 mg phosphorus, 141.68 mg potash, 368.00 mg calcium, 42.32 mg iron, 50.24 mg ascorbic acid and 52.00 µg carotene content per 100 g of edible portion. Thus, it is called as "Mines of Minerals" (Choudhary and Rajendran, 1980) [3].
Organic manures play an important role in quality production of vegetable crops. Hsich *et al*. (1994) [5] and Shankaran (1996) [10] reported that, organically grown products are high in quality. Use of organic manures such as FYM, compost, city compost, vermicompost, neem cake and poultry manures not only increase the yield but also improve physical, chemical and biological properties of soil which in turn improve fertility, productivity, water holding capacity of soil (Blane *et al*., 1989) [1]. In organic agriculture fermented liquid formulations such as panchagavya, beejamrutha, Jeevamurtha are used as plant growth enhancing substances prepared with material available with farmers. Biofertilizer is a wide term applied to a diverse category of bio-inoculants such as nitrogen fixers *Azotobacter* and *Azospirillum*. They are efficient, eco-friendly, cost effective and economically viable apart from meeting the crop nutrient requirements.
Now a days, use of heavy metals of chemicals in leafy vegetables causes serious damage to human health and soils. By consuming of vegetables grown by using organic manures and biofertilizers improves health.
Information on the use of different organic manures and bio fertilizers in the production of leafy vegetables especially in Palak is meager. Hence the present investigation was aimed to know the organic manures and bio inputs on growth, yield and quality parameters of Palak.

Material and Methods
A research trial was taken up during *Rabi* season of 2021-2022 at College of Horticulture, Venkataramannagudem, West Godavari District, Andhra Pradesh.

The experiment was laid out in Factorial randomized Block Design (FRBD) with single control in three replications in which the treatments comprised of eight levels of organic sources (V) *i.e* 50% of N FYM + 50% of N panchagavya (V_1), 50% of N FYM + 50% of N jeevamurtha (V_2), 50% of N vermicompost + 50% of N panchagavya (V_3), 50% of N vermicompost + 50% of N jeevamurtha (V_4), 50% of N poultry manure + 50% of N panchagavya (V_5), 50% of N poultry manure + 50% of N jeevamurtha (V_6), 50% of N neem cake + 50% of N panchagavya (V_7), 50% of N neem cake + 50% of N jeevamurtha (V_8) and the second factor consists of two levels of bio-fertilizers *viz*., *Azotobacter* 20g/kg seed (B_1), *Azospirillium* 20g/kg seed (B_2). The experiment included 17 (16 + Control) treatment combinations. Organic manures and liquid organic formulations were analayzed for nitrogen content at soil science laboratory at Agriculture College, Bapatla. Accordingly, the quantity of organic manures were fixed. The experimental site was well prepared, cultural practices include thinning, weeding, irrigation and manure application were followed for the healthy growth of crop. The organic manures, biofertilizers were applied as basal dose and seed treatment respectively. Control plot was maintained without any organic and bio inputs. Liquid organic formulations were applied through foliar sprays at ten days intervals during the crop growth. Data on growth, yield and quality parameters were collected and discussed below.

Results and Discussion

The data on growth, yield and quality parameters are presented in Table 1, 2, 3. The results showed that application of organic manures and biofertilizers significantly influenced the growth, yield and quality parameters of palak. From the study it was evident that organic inputs and bio fertilizers had a positive influence on growth, yield and quality of palak over control.

The treatment, 50% of N poultry manure + 50% of N panchagavya (V_5) recorded the highest plant height (21.72 cm), leaf length (14.09 cm), leaf width (8.28 cm), leaf area (365.54cm^2), leaf area index (1.90), number of leaves per plant (16.09), leaf yield per ha (32.50 t), shelf life (2.74 days), leaf chlorophyll content (45.67 SPAD unit) and ascorbic acid content (62.06 mg/100g). Fallowed by 50% of N vermicompost + 50% of N panchagavya (V_3) treatment.

In case of biofertilizer treatments, the maximum plant height (19.85 cm), leaf length (11.89 cm), leaf width (7.57 cm), leaf area (354.56cm^2), leaf area index (1.79), number of leaves per plant (12.24), leaf yield per ha (23.98 t), shelf life (1.94 days), leaf chlorophyll content (33.50 SPAD unit) and ascorbic acid content (49.01 mg/100g) were recorded in *Azospirillium* @ 20g/kg (B_2) treated plots.

Interaction between organic manures and biofertilizers was found significant with respect to growth, yield and quality parameters. The treatment combination 50% of N poultry manure + 50% of N panchagavya + *Azospirillium* @ 20g/kg (V_5B_2) recorded the highest plant height (21.80 cm), leaf length (16.86 cm), leaf width (9.17 cm), leaf area (373.55cm^2), leaf area index (1.97), number of leaves per plant (19.01), leaf yield per ha (33.99 t), shelf life (2.97 days), leaf chlorophyll content (46.58 SPAD) and ascorbic acid content (65.0 mg/100g).

Poultry manure showed positive impact on vegetative characters of the plant and enhanced the Physico-chemical properties of the soil which might be due to fact that, it contains higher amount of Iron, Zinc, Manganese, Copper and molybdenum, carbon, nitrogen and also might have increased the availability of nutrients to the plant, which in turn result in increased growth and synthesis of higher chlorophyll content in leaves. The results are in agreement with the findings of Gathala *et al*. (2007) [4] Other reason for significant increase in plant growth might be due to application of Panchagvaya that is believed to contain growth regulators *i.e* IAA and GA_3 which enhance the cell division, cell multiplication and cell elongation which in turn might have resulted in higher vegetative growth of the Palak. Similar results were also reported by Velmurugan (2005) [13] in radish, Tiamiyu *et al*. (2012) [11] in okra, Phate *et al.* (2014) [8] in spinach.

Higher shelf life might be attributed to the phenomenon of altered physiological, biological constituents of leaves as influenced by organic manures, which reduces the respiration and enzyme activity in leaves and resulted in higher storage life. These results are in accordance with findings of Linder (1985) and Shijini (2010) [9] in tomato.

Azospirillium 20g /kg had significant influence on growth and quality attributes of the plant, this might be due to the increased uptake of available major nutrients to the plant which results in the translocation of nutrients to the plant parts. It can fix large amount of nitrogen which is freely available at atmosphere and also involved in protein synthesis, increased activity of Gibberellic acid, indole acetic acid and dehydrogenase activity, which might have improved the growth characters like plant height, leaf length, leaf area and ascorbic acid content in leaves. These results are in accordance with the findings of Jadhav (2014) [6].

As per study revealed that, application of organic manures and biofertilizers had positive impact on nutritional status, growth, yield and shelf life of leafy vegetables.

Table 1: Effect of organic manures and biofertilizers on plant height (cm), leaf length (cm), leaf width (cm) of Palak.

Organic sources (V)	Plant height (cm)			leaf length (cm)			leaf width (cm)		
	AT 45 DAS			AT 45 DAS			AT 45 DAS		
	Biofertilizers (B)			Biofertilizers (B)			Biofertilizers (B)		
	B_1	B_2	Mean	B_1	B_2	Mean	B_1	B_2	Mean
V_1	18	20.2	19.1	11.87	11.08	11.47	7.57	7.43	7.5
V_2	18.04	18.67	18.35	11.65	11.16	11.4	7.56	7.38	7.47
V_3	20.48	21.62	21.05	12.71	11.33	12.02	7.97	8.15	8.06
V_4	19.1	19.34	19.22	10.92	11.92	11.42	6.7	7.88	7.29
V_5	21.64	21.8	21.72	11.32	16.86	14.09	7.38	9.17	8.28
V_6	20.06	19.1	19.58	11.73	11.7	11.72	6.58	7.67	7.12
V_7	18.64	18.7	18.67	9.97	11.43	10.7	6.22	6.97	6.59
V_8	17.2	19.33	18.27	8.63	9.63	9.13	5.58	5.95	5.76

Mean	19.15	19.85		11.1	11.89		6.95	7.57	
Control Mean			16.23			8.15			4.83
Factors	S.Em±		CD (0.05)	S.Em±		CD (0.05)	S.Em±		CD (0.05)
V	0.32		0.92	0.42		1.2	0.19		0.56
B	0.16		0.46	0.21		0.6	0.1		0.28
V X B	0.45		1.31	0.59		1.7	0.27		0.79
Control Vs. Treatment	0.47		1.35	0.61		1.75	0.28		0.81

Table 2: Effect of organic manures and biofertilizers on leaf area (cm^2), leaf area index, number of leaves per plant of Palak.

Organic sources (V)	leaf area (cm^2) AT 45 DAS Biofertilizers (B)			leaf area index AT 45 DAS Biofertilizers (B)			number of leaves per plant AT 45 DAS Biofertilizers (B)		
	B_1	B_2	Mean	B_1	B_2	Mean	B_1	B_2	Mean
V_1	347.43	345.27	346.35	1.66	1.79	1.73	8.96	11.7	10.33
V_2	331.58	342.63	337.11	1.63	1.73	1.68	7.88	9.07	8.48
V_3	360.37	364.65	362.51	1.83	1.84	1.84	15.87	13.07	14.47
V_4	357.41	358.03	357.72	1.75	1.81	1.78	9.93	12.29	11.11
V_5	357.54	373.55	365.54	1.82	1.97	1.9	13.17	19.01	16.09
V_6	358.62	362.27	360.45	1.8	1.79	1.8	10.55	13.22	11.89
V_7	338.6	352.77	345.69	1.76	1.71	1.74	8.57	10.43	9.5
V_8	340.57	341.31	340.94	1.67	1.64	1.65	7.39	9.11	8.25
Mean	349.51	354.56		1.74	1.79		10.29	12.24	
Control Mean			329.10			1.39			6.98
Factors	S.Em±		CD (0.05)	S.Em±		CD (0.05)	S.Em±		CD (0.05)
V	2.25		6.48	0.02		0.06	0.48		1.4
B	1.13		3.24	0.01		0.03	0.24		0.70
V X B	3.18		9.17	0.03		0.09	0.69		1.97
Control Vs. Treatment	3.28		9.45	0.03		0.09	0.71		2.04

Table 3: Effect of organic manures and biofertilizers on yield per ha (t), shelf life (days), leaf chlorophyll content (SPAD unit), ascorbic acid content (mg/100g) of Palak.

Organic sources (V)	yield per ha (t) AT 45 DAS Biofertilizers (B)			shelf life (days) AT 45 DAS Biofertilizers (B)			Leaf chlorophyll content (SPAD unit) AT 45 DAS Biofertilizers (B)			ascorbic acid content (mg/100g) AT 45 DAS Biofertilizers (B)		
	B_1	B_2	Mean	B_1	B_2	Mean	B_1	B_2	Mean	B_1	B_2	Mean
V_1	18.75	24.14	21.45	1.2	1.37	1.29	29.1	32.1	30.6	47.2	49.28	48.24
V_2	18.44	20.22	19.33	1.15	1.35	1.25	23.12	24.25	23.69	38.05	40.12	39.09
V_3	25.65	27.22	26.43	2.55	2.73	2.64	41.05	42.25	41.65	55.62	56.66	56.14
V_4	22.37	23.94	23.16	1.97	2.23	2.1	32.1	34.2	33.15	44.1	46.66	45.38
V_5	31	33.99	32.5	2.51	2.97	2.74	44.75	46.58	45.67	59.12	65	62.06
V_6	23.84	25.52	24.68	2.02	2.1	2.06	36.14	39.12	37.63	52.92	53.14	53.03
V_7	17.05	20.22	18.64	1.62	1.74	1.68	26.1	27.25	26.68	42.4	44.25	43.33
V_8	15.95	16.57	16.26	1.03	1.34	1.19	23.1	22.25	22.68	34.12	36.99	35.55
Mean	21.63	23.98		1.76	1.98		31.93	33.5		46.69	49.01	
Control Mean			9.49			1.10			21.10			31.26
Factors	S.Em±		CD (0.05)	S.Em±		CD (0.05)	S.Em±		CD (0.05)	S.Em±		CD (0.05)
V	0.13		0.37	0.03		0.07	0.38		1.1	0.47		1.35
B	0.06		0.19	0.01		0.04	0.19		0.55	0.24		0.68
V X B	0.18		0.53	0.04		0.1	0.54		1.56	0.66		1.92
Control Vs. Treatment	0.19		0.54	0.04		0.11	0.56		1.6	0.69		1.97

Factor I: Organic sources of nitrogen (V)
V_1: 50% of N FYM + 50% of N panchagavya
V_2: 50% of N FYM + 50% of N jeevamrutha
V_3: 50% of N vermicompost + 50% of N panchagavya
V_4: 50% of N vermicompost + 50% of N jeevamrutha
V_5: 50% of N poultry manure + 50% of N panchagavya
V_6: 50% of N poultry manure + 50% of N jeevamrutha
V_7: 50% of N neem cake + 50% of N panchagavya
V_8: 50% of N neem cake + 50% of N jeevamrutha

Factor II: Biofertilizer application (B)
B_1: *Azotobacter* 20g/kg seed
B_2: *Azospirillum*20g/kg seed

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